8.—Petrology of chert artifacts from Devils Lair, Western Australia

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Abstract

Fossiliferous chert artifacts from Devils Lair, a small cave in the Cape Leeuwin-Cape Naturaliste region, Western Australia, consist of silicified limestone (biomicrite) containing a little glauconite. Specimens examined in thin section came from deposits ranging in age from *ca* 12 000 years B.P. to more than 17 000 years B.P. They resemble fossiliferous Eocene chert from surface and near-surface sites in the Perth Basin, and are probably derived from the same formation.

Introduction

Flakes of chert and quartzite worked by aborigines have been found at many sites in and just outside the region of the Perth Basin, and form abundant components of surface or near-surface accumulations. Other utilized rock and mineral flakes, including dolerite, granite, silcrete, quartz, schist and K-feldspar are commonly present as minor constituents. Chopping and grinding tools, generally of dolerite or quartzite, are found in a few places. Some of the chert is unfossiliferous and of probable Precambrian age, but most of it is bryozoan chert of Eocene age (Glover & Cockbain 1971).

This paper describes the petrology of some chert flakes excavated from the Devils Lair cave outside the Perth Basin, and compares it with the petrology of flakes from surface scatters within the region of the basin.

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Location and age of the artifacts

Devils Lair is a small cave in Quaternary limestone (the "Coastal Limestone") on the Precambrian Leeuwin Block (Fig. 1) and it contains a deep deposit with abundant bone fragments and some stone artifacts (Dortch & Merrilees 1971, 1973). The artifact material includes chert (five individual specimens of which are described herein), quartz (*e.g.* B1558), calcrete

Figure 1.—Locality map of southwestern Western Australia. Precambrian indicated by crosses. Eocene units as follows: P = Plantagenet Group, E = Eundynie Group, T = Toolinna Limestone. All artifacts mentioned in the text, except those from Devils Lair and the Pinnacles area, come from in or near the Perth metropolitan area.

(*e.g.* B1537) and bone (*e.g.* B1573). Mr. C. E. Dortch, Western Australian Museum, gave the following information about the locality of the chert specimens examined, and the age of the strata from which they were taken:

Specimen	*Trench*	*Estimated age in years B.P.*
A22013	1A	Probably *ca* 12 000
B1513	5	*ca* 12 000
B1520	5	*ca* 14 000
A21972	1A	over 12 000
B1586	6	over 17 000

He also states (C.E. Dortch, *pers. comm.*) "Other artifacts from Devils Lair range in estimated age from less than 12 000 to more than 24 000 years old, but no chert is known at present older than about 19 000 years".

Petrology of the Devils Lair chert

Despite superficial differences in colour and opacity, the flakes are sufficiently alike in hand specimen and thin section to be described together.

Individual flakes are not uniformly coloured, but range from off-white through grey to grey-brown. Specimen A22013 ranges from off-white to brown, and is different from the other flakes in that the brown portions are vitreous rather than dull, and are very faintly translucent. The flakes have a conchoidal fracture except for the off-white parts which have an uneven fracture and can be scratched with a knife. Minute organic fragments can be detected with the hand lens. No effervescence was observed when dilute hydrochloric acid was applied to the surface of the flakes, despite the observed presence of calcite under the microscope (see below). This is probably partly because the carbonate is generally well protected by surrounding silica, and partly because the acid tends to be absorbed in the softer, off-white portions, which are porous. An X-ray powder pattern of specimen B1513 confirms the presence of calcite, but shows no dolomite.

Under the microscope the flakes are seen to consist mainly (70-85%) of a mixture of cryptocrystalline to microcrystalline silica, and coarser, commonly spherulitic, chalcedony. A variable but significant proportion (10-25%) consists of calcite, and other minerals include limonite-impregnated clay, rare silty quartz, pellets of green to brown glauconite up to 0.1 mm in diameter, and some black opaque material that is probably carbonaceous.

The calcite forms irregularly-shaped patches, or assumes the outline of fossil fragments. Most fossils have been at least partly silicified, and many are now composed entirely of silica (see Figs. 2, 3 and 4). Remains include multi-rayed calcareous spicules, foraminifers (apparently planktonic), small bivalve fragments, and bryozoans. One calcite fragment with unit extinction that is probably an echinoderm plate was seen. In addition, there are minute non-calcareous objects, too small for satisfactory observation in thin section, that may be organic.

Figure 2.—B1520. Small, thin-walled bivalve in chert. The walls are still largely carbonate, but the infilled material is cryptocrystalline silica and chalcedony. University Geology Department Neg. P2665. X 30. Crossed polarizers.

The fabric indicates that the rocks before silicification consisted essentially of fossil fragments in a matrix of finely divided carbonate, and they would therefore have been biomicrites in the terminology of Folk (1962).

Comparison with other fossiliferous chert flakes

The fossiliferous chert from Devils Lair was compared in hand specimen and thin section with fossiliferous chert from surface sites near Abernethy Road (Kewdale), Bibra Lake, Mongers Lake, Lake Gnangara, and the Pinnacles area north-east of Lancelin. The surface material ranges in colour from off-white and grey to yellow-brown, with other minor variations, but the colour differences seem largely superficial, and are apparently due to the effect

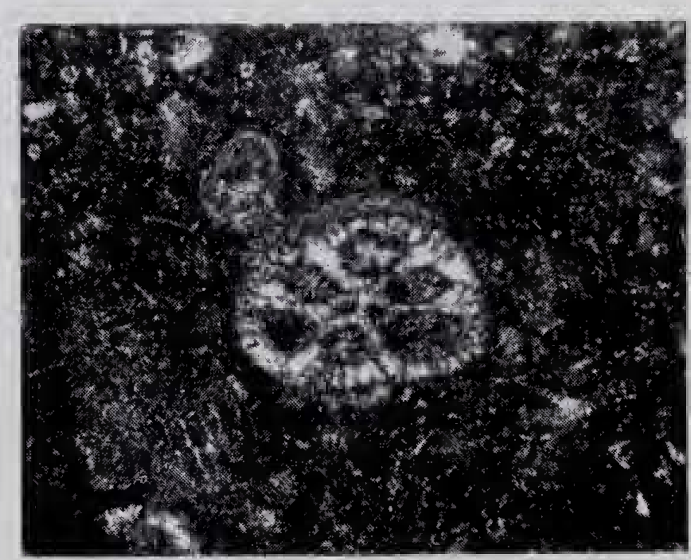

Figure 3.—B1586. Bryozoan in transverse section in chert. The walls have been completely replaced by chalcedony, and the cavities contain opaline and chalcedonic silica. University Geology Department Neg. P2661. X 27. Crossed polarizers.

Figure 4.—A21972. Foraminifer in chert. The walls are chalcedonic and the cavities are filled with opal and cryptocrystalline silica. University Geology Department Neg. P2667. X 30. Crossed polarizers.

of the beds in which they are found. As with the Devils Lair chert, all sectioned material consists of silicified biomicrite. The surface material contains less carbonate, and seems generally to have been more completely silicified. Glauconite does not occur in all material, but is present in many Pinnacles flakes.

Origin of the Devils Lair chert

The textural and mineralogical similarities between the chert from Devils Lair and from surface scatters in the Perth Basin are strong, and suggest that all have been derived from the same formation. A few large fragments of surface material are about 10 cm long in their greatest extension, and their appearance is consistent with derivation from chert nodules or irregularly silicified beds in limestone. Nothing, however, can be added at present to earlier speculation (Glover & Cockbain 1971) about a possible western source now off-shore, or an eastern or southeastern source in Eocene formations on the Yilgarn Block.

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9.—The development of the cheek-teeth in Antechinus flavipes (Marsupialia, Dasyuridae)

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Abstract

The ontogenetic development of the cheek-teeth in a developmental series of 14 pouched young of *A. flavipes* is described. There were found to be eight post-canine tooth families each of which produces only one tooth, or generation: P1, P3, P4, dP4, M1, M2, M3, M4. The canine family has two generations. The development of the upper and lower laminae differ in the posterior region probably because of the crowding effect in the mandible caused by the ascending ramus. The time of initiation of all teeth is consistent with an interpretation described by Woerdman (1921) as *Zahnreihen*. In *A. flavipes* there appear to be two *Zahnreihe* along the length of the cheek-tooth row. One is initiated at the C position and the other at the dP4 position. The molariform cheek-tooth series, the dP4-M4, represent one series of related teeth, and the C-P4 represent a second set of related cheek-teeth. The traditional definitions of premolars and molars do not apply to cheek-teeth of *A. flavipes* and if the situation that exists in this species is found to be more general among the marsupials, a more appropriate series of definitions and nomenclature may be required to differentiate the cheek-teeth.

Introduction

Numerous attempts have been made by research workers to establish a basis for identifying homologous teeth in metatherians (marsupials) and eutherians. The most commonly used basis is the phenomenon of tooth replacement. Owen (1840-5) established the basic principle that premolars were post-canine teeth which had milk predecessors. Molars were post-premolar teeth which had no milk predecessors. Accordingly, eutherians are considered to have four premolars and three molars. Metatherians, which presumably have a common ancestry with eutherians, have three premolars and four molars. Consequently it appears that metatherians have lost one premolar and gained or retained an additional molar. An alternative is that the first molar of metatherians is actually a molariform premolar. Differences in opinion about which premolar has been lost (if in fact any have been lost) have produced conflicting systems of dental terminology.

Embryological investigations have often tended only to confuse the issue. As a result of some of the earlier embryological studies, the question of the homology of the whole tooth row was raised and has been the cause of further conflicting terminologies. Most embryological investigations were, however, carried out on material inadequate to clarify the questions of premolar and molar homology. Either the studies have been based on too few or too late developmental stages (e.g. Wilson & Hill 1897, Fosse & Risnes 1972a and b), or upon excellent material of species which have incomplete series of teeth due to phylogenetic reduction (e.g. the macropodids as studied by Berkovitz 1966, and Kirkpatrick 1969, or phalangerids studied by Berkovitz 1968).

The work reported here was based on a good series of pouch young of *Antechinus flavipes* whose adult cheek-tooth dentition contains the maximum number of teeth known in any metatherian except *Myrmecobius* which appears to develop supernumary teeth of very uncertain homology; some Cretaceous *Didelphodon,* Clemens 1966, which may have had four premolars; and possibly *Garzonia,* a specimen noted by Sinclair (1906) having nine antemolar teeth of uncertain homology.

The teeth of vertebrates are basically ectodermal structures which develop from oral epithelial tissue. In reptiles (Edmund 1960), the oral epithelium invaginates as a band (the dental lamina) into the matrix of the upper and lower jaws. The free edge of the invaginating band is proliferative and sequentially along its length produces swellings which are identified as tooth buds. As these tooth buds organize and develop the tissues which will eventually produce a functional tooth, they appear to move along the buccal side of the dental lamina, in a vertical direction, towards the oral epithelium. This relative movement of the bud and the free edge of the dental lamina is responsible for the re-appearance of the free edge lingual to the established tooth bud. Subsequently, a second swelling may occur on the free edge of the dental lamina in the same position as the first. Such a vertical sequence of one or more tooth buds is referred to as a tooth family. Each bud is referred to as a tooth generation. There may be many tooth families along the dental lamina and a variable number of generations within each. The situation in mammals is basically the same (Ziegler 1972) except that the invaginated dental lamina is less sheet-like in structure, and as a result the terminal swellings occur nearer to the oral epithelium.

The work presented here is an attempt to determine the number of post-canine tooth families, and generations within those families, in the dasyurid marsupial *Antechinus flavipes.* This information is used to clarify the homologies of the cheek-teeth of metatherians.

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